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AC Motor Controller 2200W

User Manual

AC Motor Controller features

The AC Motor Controller is an advanced motor regulation, with various control inputs.
It has inputs for DMX signal, tacho sensors and potentiometers, emergency stop and limit switches.
The motor controller controls a 3-phase AC motor of maximum 2200W.
The motor is controlled by a frequency inverter, which controls the speed and force of the motor.
The frequency inverter is controlled by a control circuit, where a microprocessor control and monitor the motor, another microprocessor receives the DMX signal.

DMX channels used for controlling the motor.

(For a more detailed description see page 9)

Mode 1 Free run

DMX channel 1 – 0-9% stop, 10-39% REV, 40-69 STOP, 70-100 FWD
DMX channel 2 – Not used
DMX channel 3 – Speed
DMX channel 4 – Motor Enable – between 50 % and 55 %, to enable the motor output.

E.g Running the motor in reverse with 50% speed, set DMX values to:
DMX channel 1 = 20% (between 10-39%)
DMX channel 2 = not used
DMX channel 3 = 50%
DMX channel 4 = 53% (between 50-55%)

Mode 2-4

DMX channel 1 – Position. (16 bit DMX channel)
DMX channel 2 – Position fine. (16 bit DMX channel)
DMX channel 3 – Maximum speed
DMX channel 4 – Motor Enable – between 50 % and 55 %, to enable the motor output.
DMX channel 5 – Manual FWD, Mode 2-4 (Reset FWD only active in mode 3 & 4)
DMX channel 6 – Manual REV, Mode 2-4 (Sets the TAC RANGE in mode 4)

E.g. the motor shaft connected to a potentiometer running to the middle position at 40% speed, set DMX channels approximately to:
DMX channel 1 = 50%
DMX channel 2 = 0%
DMX channel 3 = 40%
DMX channel 4 = 52% (between 50-55%)

E.g the motor shaft connected to a tacho, TAC RANGE = 40000. Running to position 30000 at full speed, set DMX channels approximately to:
DMX channel 1 = 75%
DMX channel 2 = 0%
DMX channel 3 = 100%
DMX channel 4 = 51% (between 50-55%)

Mode 5

Manual control, no DMX channels is in use.

DMX channels 7-10 varies for extended mode.

Mode setup

The motor controller has 5 different control modes. The different modes determine which kind of motor feedback and which type of motor regulation is used. Here are the main features:

Mode 1 Free run motor can run forward and reverse at variable speeds, and it can stop.
The limit switch FWD and REV is active; meaning activating the FWD limit switch will stop the motor from running forward, and likewise for REV.

Mode 2 Positioning with analog feedback.
Position and direction can be controlled. The position is calculated from the analog feedback.
The limit switches will stop the motor if activated.
Manual forward on channel 5, manual reverse, on channel 6 is active.

Mode 3 Positioning with tacho feedback.
Position and direction can be controlled.
The limit switches will stop the motor if activated.
The motor controller calculates the position from the tacho feedback.
Manual forward on channel 5 is active. It is also used for resetting.
Manual reverse on channel 6 is active.

Resetting the forward position:
Run the motor to the forward reset position, with channel 5.
Setting DMX channel 5 to 0% resets the position.
The position after reset is set to TAC RANGE + RES OFFSET.

Mode 4 Positioning with tacho feedback, TAC RANGE reset with channel 5 and 6.
Position and direction can be controlled.
The limit switches will stop the motor if activated.
Manual forward on channel 5 is active. It is also used for resetting.
Manual reverse on channel 6 is active.

Mode 4 is intended to be used as an easy way of setting a new tacho range, this could be at the initial motor system setup, or if the mechanical range is changed. After a new range has been set, it is recommended to switch back to mode 3, to not risk changing the TAC RANGE under normal DMX control.

Resetting the forward position:
Run the motor to the forward reset position, with channel 5.
Setting DMX channel 5 to 0% resets the position.
The position after reset is set to TAC RANGE + RES OFFSET.

Setting a new range with DMX, TAC RANGE:
First reset the forward position; then find the reverse position.
Run the motor reverse with channel 6 to the reverse reset position
Setting DMX channel 6 to 0% calculates a new TAC RANGE
The new TAC RANGE is calculated as the tacho pulses between forward reset position, and the position reached with channel 6, subtracted RES OFFSET x 2.

E.g. resetting forward with channel 5 to the maximum forward position
Set channel 5 to 50% motor speed moving the motor forward, until the limit switch is reached.
Then reverse the motor to the most reverse position.
Set channel 6 to 50% speed and run the motor reverse until reverse limit switch is reached, setting channel 6 to 0% recalculates the TAC RANGE.
The TAC RANGE is calculated from the forward limit switch to the reverse limit switch, where the motor controller has counted 23731 tacho pulses between the two points.
RES OFFSET here is set to 1000, then the calculation of the new TAC RANGE = 23731 – (2x1000) = 21731. This range is instantly saved in the motor controller.

As a safety precaution, set the mode back to mode 3.

Mode 5 MANUAL CONTROL

Direction and speed can be controlled with manual pushbuttons and a potentiometer.
Manual reverse is achieved by connecting Tacho Input 0 to GND.
Manual forward is achieved by connecting Tacho Input 1 to GND.
The motor speed is adjusted with the voltage on analog input 0-5VDC.

Adjusting the motor speed can be easily done, by connecting a potentiometer between GND and +5V and connecting the potentiometer middle pin (2) to the Analog Input (Pin 3).

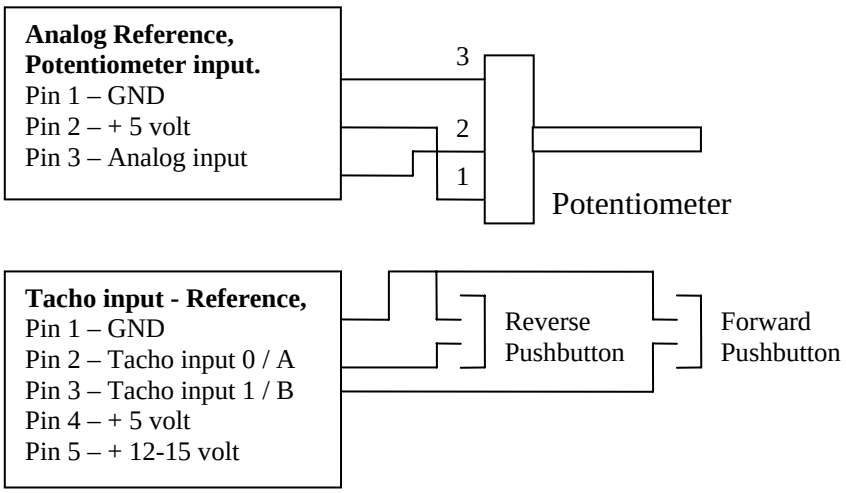


Figure 1: Connection for direction and speed controlled with buttons potentiometer.

E.g. we have a turntable; we want to turn in one direction at the push on a button. We want it to turn at one specific speed, but we need to adjust the speed to determine at which speed it should turn. Placing a potentiometer on the Analog Reference, and placing a pushbutton between GND (Pin 1) and Tacho 1 (Pin 3), will enable us to du just that. See figure 1.

Getting started with the AC Motor Controller

The Limit Switch and the Emergency Switch inputs, needs to be connected to GND, for the motor to run.

Setting up the motor parameters

The motor parameters can be found on the motor name plate.
It is very important to correctly setup the following parameters for the motor to run properly.
NOM SPEED = the nominal motor RPM, found on the motor name plate.
NOM FREQ = this is the frequency, at which the RPM is found on the motor name plate.
SPEED BOOST = boost the nominal speed from 50 – 400%, default = 100% (No speed boost).

E.g. typed on a motor name plate is: 2800RPM at 50Hz.
Then set NOM SPEED = 2800, NOM FREQ = 50 and SPEED BOOST = 100%.

Setting up DMX values

Setup MAX SPEED to the maximum speed you want the motor to run.
E.g. In the example above, the MAX SPEED is set to 2800, but you only want the motor be allowed to run 2000 RPM, then you set MAX SPEED = 2000;
But if you want the same motor to run at maximum 3000 RPM, then set SPEED BOOST to 110% and set MAX SPEED to 3000.
Most, but not all, AC motors, will run up to 200% faster than the nominal speed; some even faster.

Setting up feedback

There is some ground rules that should be followed, when choosing feedback and where to mechanically mount this feedback.

Potentiometer feedback:

Too fast changes in the analog input will make it impossible for the motor regulation to regulate the motor to stop at a specific position.
As a rule, if you want the motor regulation to use the maximum motor speed, the minimum time for the potentiometer to travel from one end to other, should not be less than one second.
This can be calculated by the following equation:

$$\frac{\text{POTENTIOMETER GEARING} \times \text{RPM}}{60 \times \text{GEARING}} \geq 1s$$

E.g. 1) 10 turn potentiometer mounted on a 1:100 gearing with a 1400 RPM motor.
(10 x 1400) / (60 x 100) = 2.33; this will work just fine.
2) 1 turn potentiometer, on the same setup as above.
(1 x 1400) / (60 x 100) = 0.233
For setup number 2, you probably have to limit the max speed to regulate to a position without overshooting.

Tacho feedback:

Too fast changes in the regulation system will make it impossible for the motor regulation to regulate the motor to stop at a specific position.
The maximum number of pulses per second should be less than 1000.
This can be calculated by the following equation:

$$\frac{\text{TACHO IMPULSES} \times \text{RPM}}{60 \times \text{GEARING}} \leq 1000\ pulses / \sec onds$$

E.g. Nominal motor RPM = 2800, 80 pulse/revolution tacho sensor on a 100:1 gearing gives us:
(2800 x 1024) / (100 x 60) = 37 pulses / seconds
This is okay for the regulation, but it may not be precise enough for your positioning, see the tacho input on page 8. It would be better to have 1024 pulses/revolution tacho, which gives 478 pulses / s.

Tuning the PID

The **PID** values:

P: Decreasing P, will slow down the regulation.
It will also reduce the maximum speed if decreased to much.

I: Increasing I, slows down the regulation. Only if P and S is set appropriately.

D: Increasing D, slows down the regulation. Only if P and S is set appropriately.

S: Increasing S, will slow the regulation down.
It will also reduce the maximum speed if increased to much.

PID values are only used in Mode 2-4.

A rule of thumb is to only adjust one PID variable at a time.
The extended mode is especially useful for initial tuning of the system, here you can get PID values on DMX channels 7-10 (EXT MODE = PIDS), afterwards you can save the values, see the menu control mode on page 11.

A good start is to use the examples here below.
You can also initially to set P= 1000, I = 0, D = 0 and S=1000.

Set the motor to run from one position to another, then you can adjust the P-value.
You adjust the value to where the motor will still be able to run at full speed.
After adjusting the P-value, adjust the S-value. The S-value should also be adjusted to make the motor be able to run at full speed.
Now you will have found the slowest regulation, that still will allow full speed, this is a good starting point.
After this, a bigger S-value will result in faster regulation. A lower S-value will result in slower regulation, but with the chosen P-value it will also reduce the max speed.
When the P and S-values is chosen, the I- and D-value can be used to fine tune the regulation.
Thus correct adjusting of the PID will only be possible if the maximum motor speed and the feedback are chosen according to the rules on page 4.

If it is not possible get the motor to reach the wanted position, i.e. if the motor will run back and forth over the selected position and never stop. This may be because of the setup itself, i.e. if a tacho gives too many pulses to the regulation. You can raise the TAC DIVIDE; this will decrease the amount of data to the regulation, but have in mind that it will also decrease the precision of the positioning.
E.g. Setting TAC DIVIDE to 8 will work if you have a 1400 RPM motor with 1024 pulses/rev mounted directly on the motor shaft.

Examples of PID setup
E.g. with 20 pulses on the motor shaft
Motor speed, nominal: 2800 RPM
Feedback: Tacho with 20 pulse/round, mounted on the motor shaft.
Set PID values: P = 1000, I = 1000, D = 1500, S = 500

E.g. with 28:1 gearing and 10 turn potentiometer
Motor speed, , nominal: 1400 RPM
Gearing: 28:1
Feedback: 10 turn potentiometer, mounted on the gearing shaft.
Set PID values: P = 500, I = 1000, D =1000, S = 1000

E.g. with 28:1 gearing and tacho with 1024 pulse/round
Motor speed, nominal: 1400 RPM
Gearing 28:1
Feedback: Tacho with 1024 pulse/round, mounted on the gearing shaft.
Set PID values: P = 600, I = 2000, D = 1000, S = 600.

Connecting the AC Motor Controller

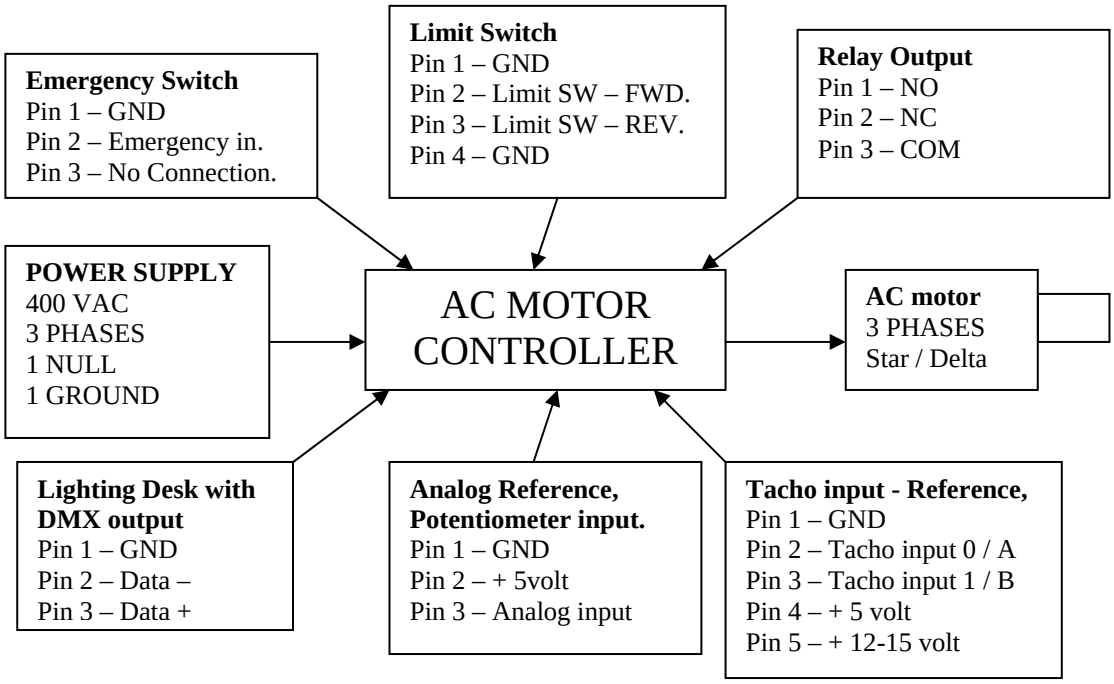


Figure 2: Connections to the AC Motor Controller

Power supply

The AC Motor Controller connects to 400VAC through the 5-pole 16A CEE male connector. It is also necessary to mount both Null and Earth.
After connecting the power, a start-up screen is displayed, it includes the software and hardware version, and after that this screen appears:

DMX CONTROL M1
START CHAN 1

DMX

DMX is connected to the male 5-pole XLR connector.
The DMX LED will light constantly when receiving a DMX signal, and it will blink when no DMX are received.

Pinout:

DMX IN	DMX OUT
Pin 1 = GND	Pin 1 = GND
Pin 2 = Data –	Pin 2 = Data –
Pin 3 = Data +	Pin 3 = Data +
Pin 4 = NC .	Pin 4 = NC.
Pin 5 = NC.	Pin 5 = NC.

Emergency stop switch

If the emergency stop switch is activated (pin 1 and pin 2 are disconnected) the red ERROR LED will light.

The emergency stop switch is connected to the female 3 pole XLR connector.
Pin 1 and Pin 2 should be connected to each other; otherwise the motor will not run.

Pinout:
Pin 1 = GND
Pin 2 = Emergency stop
Pin 3 = NC.

Limit switch

These inputs stop the motor movement in direction of the respective limit switch.
Placing the limit switches strategic at the outer positions of the maximum operating range, forces the motor to stop in the outer limit positions.
The display will show a message for the limit switch, in the Control Mode menu. Shown here; for the forward limit switch. *FORWARD LIMIT SWITCH ACTIVATED*.

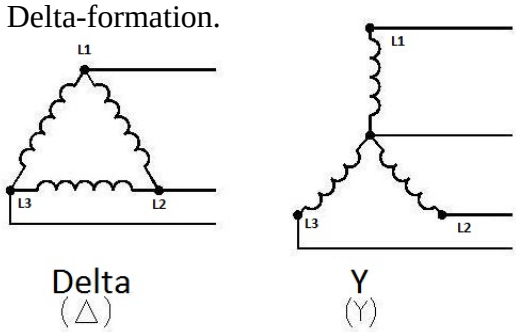
This message will not be shown in the expanded view; this is done to be able to see the position values while resetting, see page 11.
The limit switch connects to the 4 pole XLR connector.
The limit switch for the forward movement is connected to pin 1 and 2.
The limit switch for the reverse movement is connected to pin 3 and 4.
When the limit switch FWD is disconnected from GND the motor stops the forward motion.
When the limit switch REV is disconnected from GND the motor stops the reverse motion.

Pinout:
Pin 1 = GND
Pin 2 = Limit Switch Forward
Pin 3 = Limit Switch Reverse
Pin 4 = GND

Motor connection

The tree-phased motor connects to the AC Motor Controller on the female 5 pole 16A CEE connector.
230VAC / 400VAC motors needs to be connected in Y-formation (also called star formation).
400VAC / 600VAC motors needs to be connected in Delta-formation.

Pinout:
Pin L1 = Phase 1
Pin L2 = Phase 2
Pin L3 = Phase 3
Pin N = NC.
GND = Earth + motor cable shield



Analog reference

The analog reference can be used for position feedback from a potentiometer.
A potentiometer would be mechanically connected to the motor shaft, maybe through a gearbox.

Pinout:	Potentiometer:
Pin 1 = GND	potentiometer pin 1
Pin 2 = +5V supply	potentiometer pin 3
Pin 3 = Analog input	potentiometer pin 2, middle pin

Many different variants of potentiometers can be used, single-turn and multiturn or sliding potentiometers, dependent on how they can be mechanically mounted.
The multiturn potentiometers can have 1 to 78 rounds.
The main thing, using potentiometers as feedback, is that the potentiometer “ARM” or “AXIS” should be connected to the motor – movement, so when the motor moves, the potentiometer follows the movement, and feeds the motor position back into the AC Motor Controller, through the analog input.
The value of the potentiometer resistance should be between 1K and 10K ohms.
Mode 2 positions the motor from the analog feedback value.

Hint: Care needs to be taken, not to run the motor out over the potentiometers inner mechanical boundaries, as it will destroy the potentiometer.
The limit switches will stop the motor if they are activated.

Tacho input

The tacho input is used for position feedback from a tacho sensor, that is mechanically connected to the motor shaft.

Pinout:	Tacho sensor connections:
Pin 1 = GND	GND
Pin 2 = Tacho Input 0	Tacho output A or B dependent of the wanted direction.
Pin 3 = Tacho Input 1	Tacho output B or A dependent of the wanted direction.
Pin 4 = +5V Output	Tacho sensor power +5volt.
Pin 5 = +12V Output	Tacho sensor power +12volt.

The tacho sensor output 2 pulses corresponding to the speed and the direction.
The tacho sensors can be found in many different variants, a tacho sensor output pulses on the two output pins A and B. Tacho sensors is made in a wide range of variants, from 2 to 10.000 pulses per round.
Most important is that the tacho sensor “ARM” or “AXLE” should be mechanically connected to the motor – movement, so the tacho sensor gives signal-pulses when the motor moves.
With tacho sensor feedback, a reset of the position is needed at power up.
The motor position reset can be done, by running the motor forward, with channel 5, until the forward limit switch has been reached; setting channel 5 to 0% resets the motor.

It is also possible to reset the position directly if one of the limit switches is activated, see the LIM RESET menu on page 16.

The tacho sensor output A, and B is used as input for the AC Motor Controller.
The tacho sensor used must operate at +5V or +12V.

Mode 3 or mode 4 is used to positions the motor, from the tacho pulses.

Relay output

The relay output can be used to activate a motor brake system.
See DELAY and REL DELAY for options for the relay output.

Pinout:	Relay sensor connections:
Pin 1 = NC	Normally Closed
Pin 2 = NO	Normally Open
Pin 3 = COM	Common

DMX Control

When the AC Motor Controller is connected to power, a DMX lightdesk, and when the Limit Switches and Emergency Stop Switch inputs has been connected to GND, the motor controller is ready for use, and can be controlled from the lightdesk.

DMX channel description

Mode 1 Free run

DMX channel 1 – 0-9% STOP, 10-39% REV, 40-69 STOP, 70-100 FWD
DMX channel 2 – Not used
DMX channel 3 – Maximum speed
DMX channel 4 – Motor Enable – between 50 % and 55 %, to enable the motor output.

Mode 2-4

DMX channel 1 – Position. (16 bit DMX channel)
DMX channel 2 – Position fine. (16 bit DMX channel)
DMX channel 3 – Maximum speed
DMX channel 4 – Motor Enable – between 50 % and 55 %, to enable the motor output.
DMX channel 5 – Manual FWD, Mode 2-4 (Reset FWD only active in mode 3 & 4)
DMX channel 6 – Manual REV, Mode 2-4 (Sets the TAC RANGE in mode 4)
DMX channel 7 – Used in the extended DMX mode, for Acceleration and PID-P.
DMX channel 8 – Used in the extended DMX mode, for Deceleration and PID-I.
DMX channel 9 – Used in the extended DMX mode, for and PID-D.
DMX channel 10 – Used in the extended DMX mode, for and PID-S.

Mode 5

Manual control, no DMX channels is in use.

DMX channel 1 – Position. (16 bit DMX channel)

This channel, together with channel 2, makes up a 16 bit position on the motor.
A high value on channel 1 gives a high position. A low value on channel 1 gives a low position on the motor.

DMX channel 2 – Position fine. (16 bit DMX channel)

This is the fine position of the motor. This channel, together with channel 1, makes up a 16 bit position on the motor.
Channel 2 is used to fine-tune the position.

DMX channel 3 – Speed

Channel 3 is used to control the speed or the maximum speed of the motor.
If channel 3 is 0% the motor will not run.
If channel 3 is 50% the motor will run at 50% speed.

DMX channel 4 – Motor Enable 50 % and 55 %, for the motor to turn.

Channel 4 is used as an extra security channel.
The value on channel 4 needs to be between 50 and 55 %, for the motor to run.
All other values make the motor stop. All other values will also reset any error shown.

DMX channel 5 – Manual FWD, Mode 2-4 (Reset FWD only active in mode 3 & 4)

Channel 5 is used to manual move the motor forward.
When channel 5 is in use it will run the motor FWD, until it hits the limit switch FWD.
In mode 3 and 4 the position is reset. Setting DMX channel 5 to 0 resets the position.
10 – 100% makes the motor run forward, at variable speed.
(10% = low speed – 100% = full speed).

DMX channel 6 – Manual REV, Mode 2-4 (calculates a new TAC RANGE in mode 4)

Channel 6 is used to manual move the motor reverse.
When channel 6 is in use, it runs the motor in reverse, until it hits the limit switch REV.
In mode 4 the position is reset and a new TAC RANGE is calculated. The new range is the tacho pulses, between forward position set by channel 5 and reverse position set by channel 6.
10 – 100% makes the motor run recverse, at variable speed.
(10% = low speed – 100% = full speed).

Extended Mode

EXT MODE = ACCDCC

The ADCDCC mode is used to adjust the acceleration and the deceleration parameters, at setup, or during a show. Sometimes a movement needs to be fast one place in the show and slow some other time in the same show.
When the acceleration and deceleration parameters have been found, they can be saved to the memory of the motor controller, by pressing the ENT button in the extended mode menu.
It is only advisable to change the acceleration and deceleration variables during a show in Free run mode.

DMX channel 7 – Acceleration (only active when EXT MODE = ACCDCC)

Channel 7 is used to adjust the acceleration of the motor regulation.
0 – 100% sets the acceleration.
(0% = lowest acceleration – 100% = highest acceleration).

DMX channel 8 – Deceleration (only active when EXT MODE = ACCDCC)

Channel 8 is used to adjust the deceleration of the motor regulation.
0 – 100% sets the deceleration.
(0% = lowest deceleration – 100% = highest deceleration).

EXT MODE = PIDS

The PIDS mode is used to adjust the PIDS parameters at setup or adjusting them during a show. At times the regulation needs to be smooth and at other times it needs to be as fast as possible during a show. Will not have any effect in mode 1
When the PIDS parameters have been found, they can be saved to the memory of the motor controller, by pressing the ENT button in the extended mode menu.

DMX channel 7 – PID-P (only active when EXT MODE = PIDS)

Channel 7 is used to adjust the P value of the PID motor regulation.
0 – 100% sets the P value, P = channel7 in % multiplied with 50.
E.g. 10% -> P = 500, 20% -> P = 1000.

DMX channel 8 – PID-I (only active when EXT MODE = PIDS)

Channel 8 is used to adjust the I value of the PID motor regulation.
0 – 100% sets the I value, I = channel 8 in % multiplied with 50.
E.g. 7% -> I = 350, 30% -> I = 1500.

DMX channel 9 – PID-D (only active when EXT MODE = PIDS)

Channel 9 is used to adjust the D value of the PID motor regulation.
0 – 100% sets the D value, D = channel 9 in % multiplied with 50.
E.g. 35% -> D = 1750, 40% -> D = 2000.

DMX channel 10 – PID-S (only active when EXT MODE = PIDS)

Channel 10 is used to adjust the S value of the PID motor regulation.
0 – 100% sets the S value, S = channel 10 in % multiplied with 50.
E.g. 22% -> S = 1100, 40% -> S = 2000.

MENU

The menu structure is divided into two different areas for safer motor control.

Control mode

The display shows:	DMX CONTROL M1
M1 refers to the actual mode	START CHAN 1
It can also be controlled manually	MANUAL CONTROL
M5 refers to the actual mode.	M5 .

Control mode – Expanded view

Expanded view is activated by holding the DOWN button for approx 5 seconds.
Here it is possible to watch the different parameters:

P = ACTUAL POSITION D = DELTA POSITION
W = WANTED DMX POSITON S = SPEED

Holding the DOWN button for further 5 seconds will reveal the received DMX values in the menu. The value is shown in the menu as this:

CH1 CH2 CH3 CH4
CH5 CH6 CH7 CH8

If in extended mode holding the DOWN button for further 5 seconds will reveal the extended mode values in the menu. These values are shown in the menu for different EXT MENU:

EXT MENU = ACCDCC
ACC: Acceleration
DCC: Deceleration

EXT MENU = PIDS
P: PID-P value I: PID-I value
D: PID-D value S: PID-S value

In the extended mode value menu, holding down ENT, for approximately 5 seconds will save the values selected by DMX.
This makes it easy to adjust e.g. PID values and save them to the AC Motor Controllers memory.

Menu navigation mode

Top Line shows MENU NAVIGATE

In menu navigate mode, the different parameters can be changed, e.g. DMX, address, PID setup etc. In menu navigate mode the motor is stopped and DMX input has no effect, the motor can be moved by the MAN FWD/REV menu though.

Menu mode change

MENU - NAVIGATE:
The top line of the display is showing: DMX CONTROL M1
Push the buttons UP & DOWN and hold them for 3 seconds.
Now the top line of the display should show: MENU NAVIGATE

MENU - DMX CONTROL:
Go back to the starting position and activate DMX control
The top line of the display is showing: MENU NAVIGATE
Push the buttons UP & DOWN and hold them for 3 seconds.
Now the top line of the display is showing: DMX CONTROL M1

Navigate the menu

The top line of the display is showing: MENU NAVIGATE
Push the buttons UP or DOWN to go up and down in the menu choices.
The bottom line of the display is showing: DMX ADDR 1

Adjusting menu parameters

The top line of the display is showing: MENU NAVIGATE
The bottom line of the display is showing: DMX ADDR 1
Push ENT to change the DMX ADDR value.
The top line of the display is showing: EDIT MENU VALUES
The bottom line of the display is showing: DMX ADDR 1

Save changed value

The top line of the display is showing: EDIT MENU VALUES
The bottom line of the display is showing: DMX ADDR 270
Push ENT to change the top line to: SAVING 1-20
Then press and hold ENT
The top line of the display counts up to 20 then shows OK. SAVING OK
The Value is now saved in the memory.

Adjustable parameters

		Range	**Default**
MAN SPEED	Speed for manual driving	100 – 6000	500
MAN FWD/REV	Run the motor manual from the menu	MOTOR FWD / MOTOR REV / STOP	
DMX ADDR	DMX start address	1 – 506	1
CTRL MODE	Control Mode	1 – 5	1
EXT MODE	Extended Mode	1 – 2	NONE
AN FWD LIM	Analog position forward limit	0 – 10000	9900
AN REV LIM	Analog position reverse limit	0 – 10000	100
TAC RANGE	Motor range in tacho mode	0 – 50000	20000
TAC DIVIDE	Tacho divider	1 – 512	1
LIM RESET	Limit switch to reset the position	1 – 4	NONE
RES OFFSET	Reset offset value	0 – 4000	0
SPEED MAX	Maximum speed	100 – 15000	1400
SP MIN FWD	Minimum speed FWD	0 – 1000	150
SP MIN REV	Minimum speed REV	0 – 1000	150
ACC RAMP	Accelerations ramp	50 – 10000	2500
DEC RAMP	Decelerations ramp	50 – 10000	4800
NOM SPEED	Motor nominal speed	100 – 6000	1400
NOM FREQ	Motor nominal frequency	50 or 60	50
TORQUE	Motor torque setup	0 – 42	0
SPEED BOOST	Motor speed boost	50 – 400	100
PID P	PID regulator Power setup	50 – 5000	1000
PID I	PID regulator Integrator setup	0 – 5000	600
PID D	PID regulator Differentiate setup	0 – 5000	0
PID S	PID regulator S setup	50 – 5000	850
PRECISION	Precision	1 – 500	100
RELAY	Relay output	1 – 6	DMX OFF
REL DELAY	Relay delay	0 – 250	0.3
FACTORY	Restore to factory settings		

MAN SPEED and MAN FWD/REV is used for manual control of the motor.

Detailed explanation of all parameters

MAN SPEED Speed for manual driving. Range 100 – 6000

MAN SPEED sets the speed for manual driving the motor.
6000 sets the maximum speed to 6000 RPM and 100 sets the minimum speed.

MAN UP/DWN Manuel driving the motor.

MAN UP/DWN is used for manual control of the motor.
Pressing the UP button, makes the Rollup run up, unless the limit switch is activated.
Pressing the DOWN button, makes the Rollup run down, unless the limit switch is activated.
The Rollup will stop if the Emergency Switch is activated.

DMX ADDR DMX start address Range 1 - 506

DMX start address defines which DMX address the motor controller reacts on.
The AC Motor Controller uses minimum 6 DMX channels.

CTRL MODE Control Mode Range 1 - 5

The AC Motor Controller has five different control modes, Mode 1 to Mode 5

Mode 1 The motor runs free run, without positioning.
Mode 2 Positioning mode with analog feedback, e.g. potentiometer.
Mode 3 Positioning mode with tacho feedback.
Mode 4 Positioning mode with tacho feedback and range set.
Mode 5 Manual mode, no DMX used.

EXT MODE Extended DMX Mode Range 1 - 2

In the expanded view in the display, it is possible to save the ACC and DCC or PIDS values to memory, see page 11.

NONE No extended DMX channels in use

ACCDCC DMX Channel 7 sets the acceleration and DMX channel 8 sets the deceleration.
This is used to setup acceleration and deceleration ramps.
ACC RAMP is overridden by the DMX percentage value of channel 7 times 100.
DEC RAMP is overridden by the DMX percentage value of channel 8 times 100.
The new value is calculated by multiplying the DMX percentage with 100.
E.g.
Channel 7 at 10 % -> ACC RAMP = 1000 -> slow acceleration.
Channel 8 at 100 % -> DCC RAMP = 10000 -> fast deceleration.

PIDS DMX Channel 7-10 adjusts the PIDS values for the PID motor regulation.
This is used in mode 2-4 to setup the motor regulation.
See PID menu for details.
PID P Channel 7, % multiplied by 50
PID I Channel 8, % multiplied by 50
PID D Channel 9, % multiplied by 50
PID S Channel 10, % multiplied by 50
The new values are calculated by multiplying the DMX percentage with 50.
E.g.
Channel 7 at 20 % -> PID P = 1000
Channel 8 at 10 % -> PID I = 500
Channel 9 at 30 % -> PID D = 1500
Channel 10 at 10 % -> PID S = 500

The PIDS extended mode is especially useful for initial tuning of the system.

AN FWD LIM **Analog Forward Limit** **Range** **50 – 10000**

This is the forward analog position limit. Only used in mode 2, Analog Feedback
It is used to limit the range the motor can move, meaning if set to 5000, max DMX value will only let the motor run from 50 to 5000, see also AN REV LIM

AN REV LIM **Analog Reverse Limit** **Range** **50 – 10000**

This is the reverse analog position limit. Only used in mode 2, Analog Feedback
It is used to limit the range the motor can move, meaning if set to 2500, minimum DMX value will only let the motor run 10000 to 2500, see also AN FWD LIM

TAC RANGE **The motor working range** **Range** **0 – 50.000**

The TAC RANGE sets the working range (pulses) of the motor.
This is only used with tacho feedback mode 3+4
E.g. with 20 tacho pulses on the motor and a gearing of 1:28 gives
1 round = 20*28 = 560 pulses in TAC RANGE.
50 rounds = 50*20*40 = 5600 in TAC RANGE.
Tacho range is limited to 50.000.
If you want to have longer range you have to raise the tacho divider, see TAC DIVIDE below.

TAC DIVIDE **Tacho pulse divider** **Range** **1 – 512**

Define the divider for the tacho feedback. Used for adjusting the pulse number so the AC Motor Controller regulator does not get overrun.

E.g.

Tacho directly on the motor, 1024 pulses per round.	1.024 pulses.
Gearing of 50:1, one round on the gearing output shaft	51.200 pulses.
Rounds on the gearing output shaft, 40 rounds.	2.048.000 pulses.

To have less than 50.000 pulses, the divider needs to be 64:
1.024*50*40 = 2.048.000 which means with a 64 divider, pulses is 2.048.000 / 64 = 32.000.
This is within range. Set TAC DIVIDE = 64 and TAC RANGE = 32.000.

LIM RESET **Limit switch position reset** **Range** **1 – 4**

Defines which activated limit switch resets the tacho position.

NONE	Do not reset the tacho position by any limit switch.
FWD	Resets the position to TAC RANGE + RES OFFSET if the FWD limit switch is activated.
REV	Resets the position to 0 - RES OFFSET if the reverse limit switch is activated.
FWD+RE	Resets if either of the limit switches is activated see FWD and REV above.

E.g. LIM RESET = FWD, TAC RANGE = 30000 and RES OFFSET = 1000.
If the FWD limit switch at some point activates the FWD limit switch it will reset the position to 30000 + 1000. This will run the position 1000 pulses reverse from the limit switch. In this way, the limit switch would only be reached if a problem occurs and if this happens, it will automatically reset to its correct position again.

RES OFFSET **Set the reset position offset** **Range** **0 – 4000**

Set some distance between the position where to reset, and the operational range.
This can be used to run away from the limit switch, after a limit switch reset.
If RES OFFSET = 1000, reaching FWD limit switch (LIM RESET = FWD or FWD+RE) will reset to 1000 tacho pulses away from the limit switch. See also LIM RESET above.

SPEED MAX **Maximum speed** **Range** **100 – 15000**

SPEED MAX sets the speed for mode 1 and the maximum speed for mode 2-4.
If set to 1000, it means the motor run at 1000 RPM when DMX speed is set to full. SPEED MAX can be used lower the maximum speed, e.g. while learning the system.

SP MIN FWD **Minimum speed forward.** **Range** **0 – 1000**

The motor minimum speed, for the forward direction.
The motor is allowed to run at different minimum speed for each direction, this is to differentiate between different mechanical loads, for forward and reverse, see SP MIN REV.
Set this value to a speed where the motor will still run forward at full load.

SP MIN REV **Minimum speed reverse** **Range** **0 - 1000**

The motor minimum speed, for the reverse direction.
The motor is allowed to run at different minimum speed for each direction, this is to differentiate between different mechanical loads, for forward and reverse see SP MIN FWD.
Set this value to a speed where the motor will still run reverse at full load.

ACC RAMP **Acceleration ramp** **Range** **50 – 10000**

ACC RAMP sets the accelerations ramp on the motor control, in 1/min/sec.
ACC RAMP values of 500 is slow and 10000 is very fast acceleration.

DEC RAMP **Deceleration ramp** **Range** **50 – 10000**

DCC RAMP sets the decelerations ramp on the motor control, in 1/min/sec.
If the ramp is set too steep, the motor controller can shut shuts down and issues the error message, Overvoltage. DEC RAMP value of 500 is slow deceleration and 10000 is very fast.

NOM SPEED **The motor nominal speed setting** **Range** **100 – 6000**

The motor nominal speed value is the speed of the motor without load; the motor controller needs to know this value to correctly control the motor.
This NOM SPEED value is found on the motor name plate.
See also NOM FREQ below.
E.g.
The name plate reads 1400RPM at 50Hz, then set NOM SPEED to 1400 & NOM FREQ to 50

NOM FREQ **Motor nominal frequency setting** **Range** **50 or 60**

The motor nominal frequency is the frequency, at which the motor nominal speed is given.
Found on the motor name plate. Most times both a speed at 50 and 60 Hz is given.
See also NOM SPEED above.

TORQUE **Motor torque setup** **Range** **0 – 42**

TORQUE sets the maximum torque of the motor.
0 = normal power, and 42 is the highest motor torque.
To high a TORQUE setup can result in overheating the motor at continually use.

SPEED BOOST **Motor speed boost** **Range** **50 – 400 %**

This is used to be able to raise the maximum RPM of the motor.
If a motor nominal is set to 1400 at 50 Hz, raising the SPEED BOOST to 200% will enable the motor run double the RPM (1400 x 200% = 2800).
Not all AC motors are capable of running faster, than nominal frequency.
Most AC motor though, can run at twice the original speed.

PID **P – I – D and S, Are all parameters for adjusting the motor control.**

The PID regulation regulates the motor speed until the position has been reached.
The PID regulation is only used for mode 2-4.
See Tuning the PID on page 5, or searching the internet for PID tuning, this will reveal several thousands of sources of information on PID regulation and tuning.
A very useful rule of thumb is to only change one PID value at a time.

PID P	PID regulator Power setup	Range	50 - 5000
PID I	PID regulator Integrate setup	Range	0 - 5000
PID D	PID regulator Differentiate setup	Range	0 - 5000
PID S	PID regulator S setup	Range	50 - 5000

PRECISION **Precision** **Range** **1 – 500**

The precision parameter is used to adjust the positioning system.
This parameter sets how accurate the positioning system stops at the wanted position.
Low values give precise positioning, and a high value gives a less precise positioning.
The precision value determines when the regulation may stop the motor

E.g. when precision set to 100, the motor regulation stops when the wanted position and the actual position gets within 100 pulses from each other, see the values on the expanded menu when finding a position, see page 11.

RELAY **Relay output** **Range** **1 – 6**

Setup the relay output. It has the following options:

OFF = the relay is always off.
ON = the relay is on when power is applied to the AC Motor Controller.
BROFF = the relay turns off when the motor stops.
BRON = the relay turns on when the motor stops.
DMXOFF = the relay turns off only when DMX speed = 0.
DMX ON = the relay turns on only when DMX speed = 0.

E.g

1) The relay output = BROFF, set to release a motor brake whenever the motor speed is more than 0.
2) The relay output = DMXOFF, set to release a motor brake whenever the DMX speed is more than 0.

REL DELAY **Relay delay** **Range** **0 – 250**

REL DELAY sets the seconds of delay time for the relay output.
The value is shown in seconds, with one decimal, so a value of 0.3 = 300ms delay.
E.g. RELAY = DMXOFF and REL DELAY = 0.5, turns the relay on, when the DMX speed is not 0%, and releases the relay 0.5 seconds after DMX speed is set to 0% again.

FACTORY **Restores the original the factory settings**

All settings, DMX address and so on, will be overwritten.

LED Functions

DMX LED

The DMX lamp will light steady green when receiving a DMX signal.
The DMX lamp will blink green if no DMX signal is present.

Error LED

The error LED will light red if there is an error.
I.e. if an emergency stop is present.
Reset error is done by toggling the emergency switch, or by setting DMX channel 4 to 0.
When the Error LED lights red, there will also be an error description in the display.

Error codes

AC Motor Controller will not start, display shows nothing.	Check if the AC Motor Controller is connected to mains power incl. Null, and Earth.
The AC Motor Controller will not start, DMX lamp is blinking.	Check DMX connection.
The motor will not run, DMX LED is steady green.	Check limit switch inputs are connected.
The motor stops running after some time.	The surrounding temperature has made the AC Motor Controller to hot, above 70 °C (158 °F), so it has turned off the motor output. Reactivate the output by toggling the emergency stop, or by setting DMX channel 4 to 0.

Note 1:
The AC Motor Controller is designed to positioning a motor.
When running a motor continuously, the AC Motor Controller can become very hot.
Above 70 °C (158 °F) it will disable the motor output.
If the AC Motor Controller motor output disables, because of over temperature, you can mount a heat sink on the bottom of the AC Motor Controller, to direct some of the heat away.
If a heat sink it is not enough, a fan can be used to force air over the heat sink to make sure the temperature stays below 70 °C (158 °F).

If an error has occurred, it can be reset by toggling the emergency stop, or by setting DMX channel 4 to 0.

Technical specifications

Power supply	360-460VAC, 47-63 Hz. 3 phase incl. null & earth.
Power consumption, total max.	2500W
Motor voltage	3-phase 400VAC, Freq. regulated 16 KHz. switch freq.
Motor	3-phase AC motor, 400VAC, up to 2200W 4.5A (see Note 1)
DMX control signal	DMX 512.
DMX channels	4-10 channels.
Position sensor	2 channel tacho sensor, potentiometer input 1-10Kohm.
Ambient temperature range	0-40 °C / 32-104 °F
Weight	2 Kg. / 4.4Lbs.
Dimension	H – L – W / 125*345*105 mm. / 4.9*13.6*4.2 Inch.

Cheat sheet

Mode overview

Mode 1 Free run
Mode 2 Analog Feedback
Mode 3 Tacho Feedback
Mode 4 Tacho Feedback with TAC RANGE adjustment
Mode 5 Manual, Tacho 0 = REV, Tacho 1 = FWD, Analog = Speed

DMX channels

Mode 1
DMX channel 1 – Direction 0-25%
Mode 2-4
DMX channel 1 – Position (16 bit DMX channel)
DMX channel 2 – Position fine (16 bit DMX channel)
Mode 1-4
DMX channel 3 – Maximum speed
DMX channel 4 – Motor Enable – between 50 % and 55 %, to enable the motor output
Mode 2-4
DMX channel 5 – Manual FWD, Mode 2-4 (Reset FWD only active in mode 3 & 4)
DMX channel 6 – Manual REV, Mode 2-4 (Sets the TAC RANGE in mode 4)

Extended mode = ACCDCC
DMX channel 7 – Used for the extended DMX mode i.e. acceleration
DMX channel 8 – Used for the extended DMX mode i.e. deceleration

Extended mode = PIDS
DMX channel 7 PID P
DMX channel 8 PID I
DMX channel 9 PID D
DMX channel 10 PID S

Motor setup

NOM SPEED = RPM found on the motor name plate.
NOM FREQ = the frequency corresponding to the RPM on the motor name plate 50/60Hz.
MAX SPEED = the maximum RPM set by DMX.

Connecting the AC Motor Controller